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OCR A Level Computer Science

H446 – Paper 2

3

Bubble sort and insertion sort

Unit 12 Algorithms

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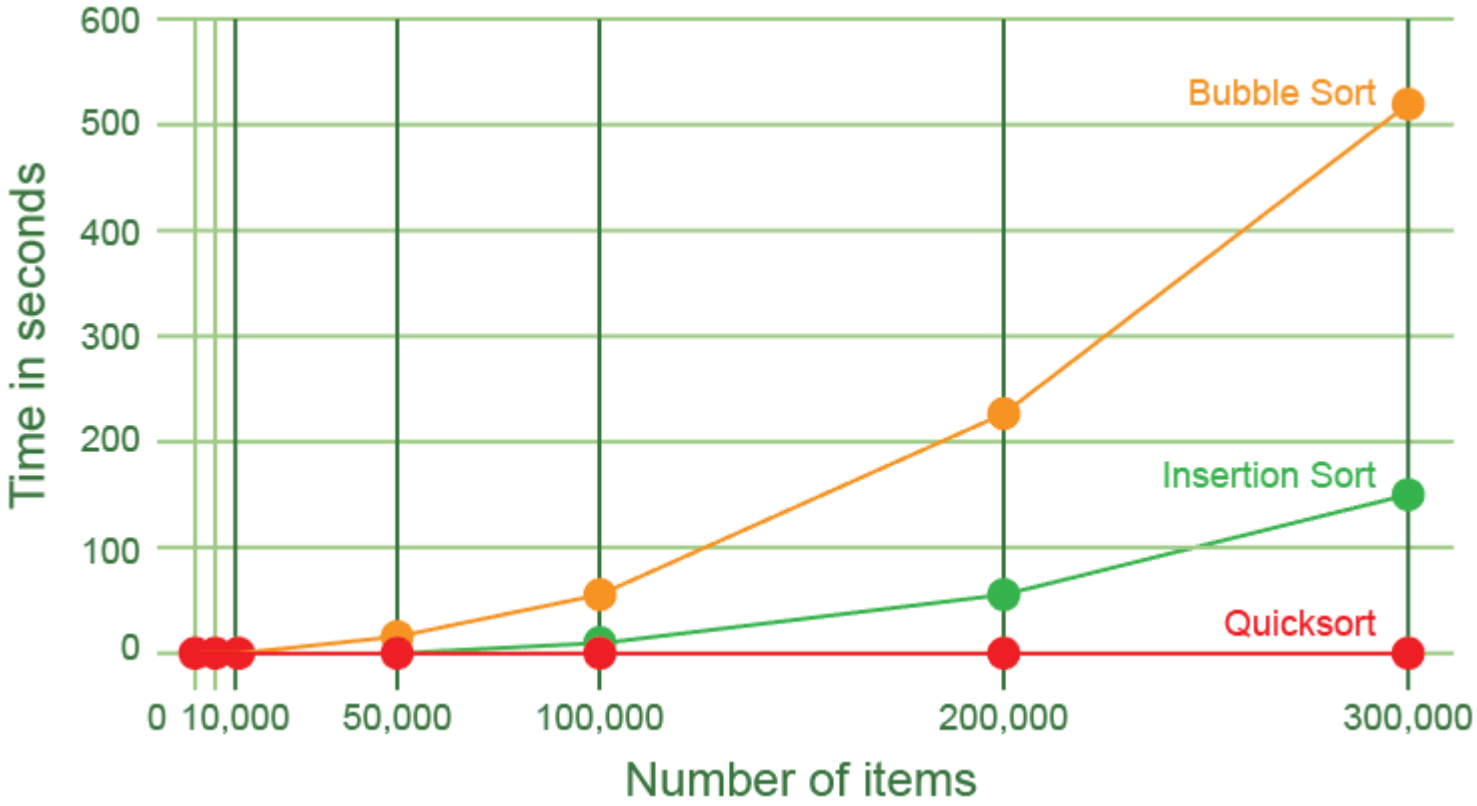
Objectives

- Be able to describe the bubble sort and insertion sort algorithms
- Be able to trace the bubble sort and insertion sort algorithms

Sorting algorithms

- Sorting is a very common task in data processing
- Frequently the number of items to be sorted is huge. So it is important to choose an efficient sorting algorithm
- The quicksort is nearly 3000 times faster than the bubble sort for sorting 100,000 items!

Time performance of sorting algorithms



Choosing a sort algorithm

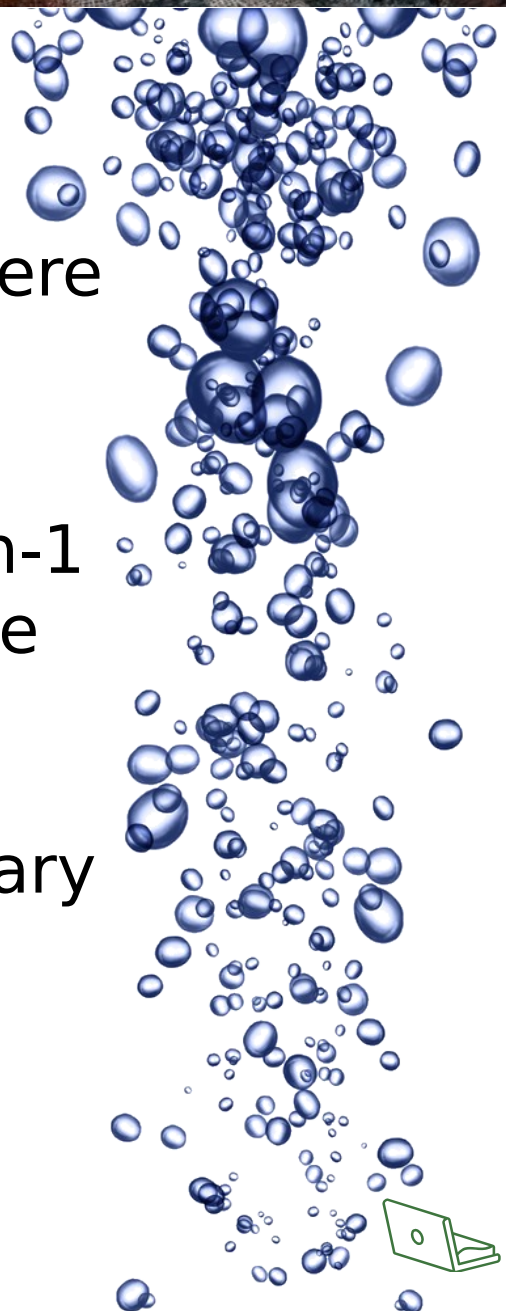
- Why would anyone choose a bubble sort when a quicksort is so much faster?
- There are international competitions to design the fastest sort algorithm…

Choosing a sort algorithm

- If there are only a small number of items to sort, a bubble sort may be perfectly adequate
- 0.6 of a second to sort 10,000 items sounds reasonable
- A week to sort 3 million items – not so good!
- Also, some sort algorithms take a lot of memory and that may be a problem with a large dataset

Bubble sort

- This is a useful sort when there are only a small number of items to be sorted
- To sort an array of n items, n-1 passes are made through the array, with each item being compared with the adjacent item and swapped if necessary



Bubble sort algorithm

```
for i = 0 to n - 2
  for j = 0 to (n – i - 2)
    if a [j] > a[j + 1]
      swap the items
endif
  next j
next i
```

- Trace through the algorithm for `a[7,4,6,8,1,5]`
- Write the code for the line "`swap the items`"

Analysing the bubble sort

- How many statements are there in the worst case scenario, in which a swap is made every time?
- Assume that “swap the items” counts as three statements

```
for i = 0 to n - 2
  for j = 0 to (n – i - 2)
    if names[j] > names[j + 1]
      swap the names
    endif
  next j
next i
```

Big-O for bubble sort

- The three statements in the inner nested loop are performed n(n-1 + n-2 + n-3 +..... 1)
- This is approximately 3 x ½ n^2 statements
- Ignoring the constant, time complexity = $O(n^2)$

```
for i = 0 to n - 2
   for j = 0 to (n – i - 2)
      if names[j] > names[j + 1]
         swap the names
      endif
   next j
next i
```

Worksheet 3

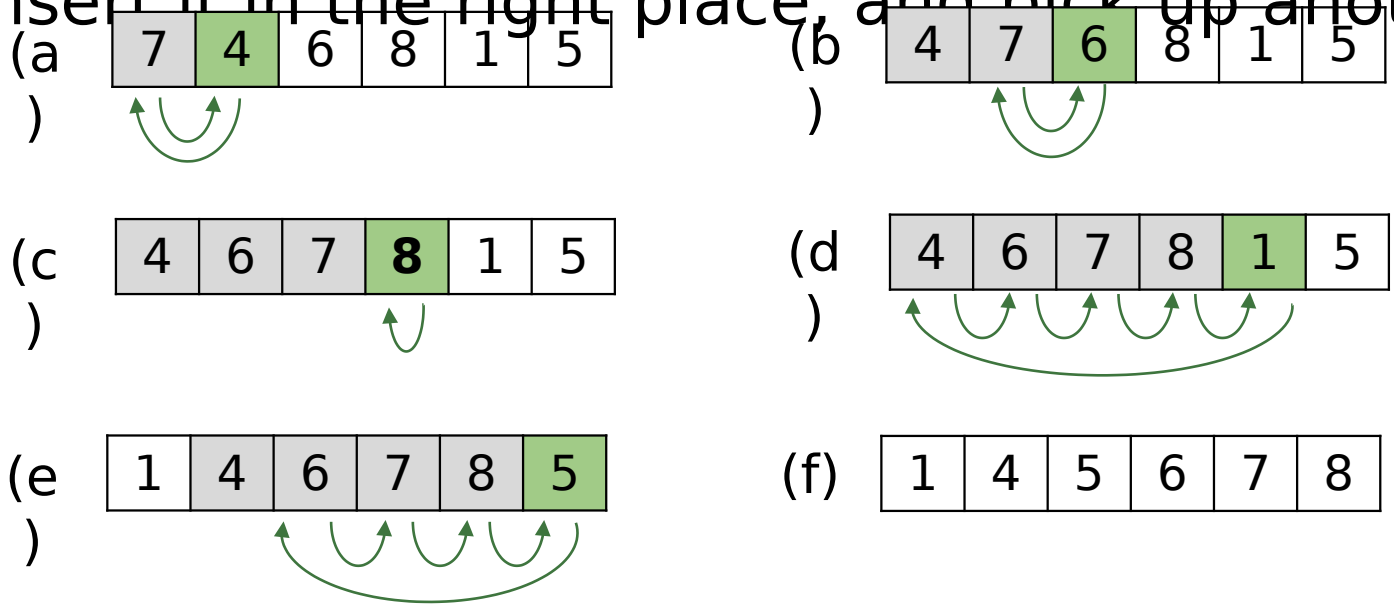
- Do **Task 1** on Worksheet 3

Insertion sort

- The insertion sort is an efficient algorithm for sorting a small number of elements
- It works in the same way you might sort a deck of playing cards
  - Start with all the cards face down
  - Pick up each card in turn and insert it into the correct place in the deck

How the Insertion sort works

- Suppose we have six numbers to sort
- The green card is the card you pick up each time
- Insert it in the right place, and pick up another



Algorithm for insertion sort

```
procedure insertionSort(aList)
     for j = 1 to len(aList) - 1
        nextItem = aList[j]
        i = j – 1
        while i >= 0 and aList[i] >
nextItem
           aList[i + 1] = aList[i]
        i = i - 1
        endwhile
     aList[i + 1] = nextItem
     next j
endprocedure
```

Worksheet 3

- Do **Task 2** on Worksheet 3

Time complexity of insertion sort

- Look again at the algorithm for the insertion sort
  - How many loops does it have?
  - Does it have nested loops?
  - How many times is each loop performed?
  - Can you work out the Big O time complexity?

Time complexity of insertion sort

- The insertion sort algorithm has two nested loops
- The outer loop is performed n-1 times
- The inner loop, which moves the items along to make room for the current item, is performed a maximum of n-1 times
- The Big-O time complexity $O(n^2)$

Plenary

- You need to be able to describe how the bubble sort and the insertion sort are carried out
- They both have the same time complexity $O(n^2)$ but the insertion sort is generally faster, although of the same order – e.g. the bubble sort may take twice as long to sort 10,000 items

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